

Appl. No. : 09/993,069  
Amdt. dated August 21, 2003  
Reply to Office Action of 07/21/03

**Remarks/Arguments**

Examiner Stephen D. Rosasco is thanked for thoroughly reviewing the subject application. All claims are believed to be in condition for allowance.

Examiner is also thanked for pointing out a number of inaccuracies existing in the specification of the application. The specification has been carefully reviewed, the editorials pointed out by Examiner have been corrected in addition to others. The specification is now believed to be in acceptable form.

Claims 1-28 are pending under this Office Action.

**Detailed Action**

The specification has been carefully reviewed, the editorials pointed out by Examiner have been corrected in addition to others. The specification is now believed to be in acceptable form.

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Regarding claims 1 and 14, Applicant respectfully disagrees with Examiner's assertion that insufficient antecedent basis exists in the specification for the limitation of "removing Ga stain". Applicant quotes for the specification, starting on page 17, as follows:

"The cross section of Fig. 5 shows that the PSM is now ready for repair which is performed using conventional methods of Focused Ion Beam (FIB) repair, with the developed layer 26 of photoresist protecting the layer 22 and 24 of shifter material. The FIB repair method focuses the ion beam 31, Fig. 6, on the region 24 of required repair, however scattered Ga ions will as yet impact the surface of the substrate 10. Focused Ga ions will also impact the substrate 10 underlying the area of repair at the completion of the repair activity, this effect of impact however can be limited by precise control of the repair action.

During the repair action, affected by FIB 31, Fig. 6, the developed layer 26 of photoresist protects the pattern 22 of phase shifter material.

The completion of the repair action is shown in cross section in Fig. 7 with the removal of the excess width of layer

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24, Fig. 6, from the surface of substrate 10. At this time the effect of the Ga implants into the surface of substrate 10 must be removed, which is achieved by applying an oxygen plasma etch 30 to substrate 10, Fig. 8, by heating substrate 10 in a highly oxidized environment. Substrate 10 is baked at a temperature of about 400 degrees C. with a range of about 350 to 450 degrees C. under a pressure of about 450 Torr with a range between about 400 and 500 Torr with O<sub>3</sub> plasma flow of about 5,000 sccm/min. with a range of about 4,000 to 6,000 sccm/min.

Plasma etch 30 restores the surface of substrate 10 where the Ga has impacted this surface by removing an upper layer of surface 29 of substrate 10. The removal of an upper layer of substrate 10 does have an impact on the phase angle of the PSM but this impact has been observed as being small enough so that the PSM still performs within the limits of the performance specifications of the PSM 15."

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Claim rejections - 35 U.S.C. § 102

Reconsideration of the rejection of claims 1-7 under 35 U.S.C. 102(e) as being anticipated by Grenon et al. (U.S. Patent 6,165,649) is respectfully requested based on the following.

Grenon et al. provides a number of methods for repair of photomasks, more specifically Grenon et al. provides for a coating, which may comprise a polymer, a metal or a material that can be selectively etched relative to the material that is used for the photomask substrate, applied over the mask to prevent damage to clear regions of the mask during laser ablation splatter, further to prevent quartz pitting caused by laser ablation, further to prevent laser deposition staining and to prevent Ga staining by FIB exposure.

As an alternate embodiment, a coating, of for instance polymer, carbon, a number of inorganic films, metals, is deposited over the quartz substrate of the photomask prior to the creation of the opaque pattern there-over, as highlighted in Figs. 5a-5d of Grenon et al.

In all of the embodiments of the invention that is provided by Grenon et al. a coating is provided for purposes of protecting participating and exposed surfaces of the photomask against side-effects of mask repair that have been highlighted above.

By contrast, making the Grenon et al. invention basically different from the claimed invention, the claimed invention as is clear from the specification of the claimed invention but as is even more clear from Fig. 4 of the claimed invention and from supporting Figs. 3, 5-9 and the there-with associated text of the specification, at no time does Grenon et al. provide for exposing a layer of photoresist, which is deposited over a second surface of the photomask, from a first surface of the photomask, as is shown with exposure 28 in the cross section of Fig. 4, the results of which are shown in the cross section of Fig. 5 after the exposed layer of photoresist has been developed.

These latter aspects of the claimed invention are further supported by for instance claim 1, which specifies a method of repairing a Phase Shift Mask (PSM), while maintaining desired

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transmission rate and phase angle of the PSM and which is quoted following, thereby underlining where the claimed invention differs for the Grenon et al. invention:

- providing a Phase Shift Mask (PSM) having a first and a second surface, said PSM having been provided with a pattern of phase shifter material over the second surface of said PSM, said pattern of phase shifter material comprising at least one faulty element;
- depositing a layer of photoresist over the second surface of said Phase Shift Mask, including the surface of said pattern of phase shifter material provided over the second surface of said PSM
- exposing the first surface of said PSM, thereby exposing said deposited layer of photoresist except where said layer of photoresist is shielded by said pattern of phase shifter material provided over the second surface of said PSM
- developing said exposed layer of photoresist, removing said layer of photoresist from in between said pattern of phase shifter material over the second surface of said PSM, leaving said layer of photoresist in place overlying said pattern of phase shifter material including said at least one faulty element

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- repairing said at least one faulty element present in said pattern of phase shifter material
- removing Ga stain from the second surface of said PSM, and
- removing said developed layer of photoresist from the surface of said pattern of phase shifter material.

In short: Grenon et al. provides a coating for the protection of surfaces that are potentially negatively impacted by actions of repairing a photomask, the instant invention, the instant invention differs from the Grenon et al. invention by developing a layer of photoresist over the opaque pattern of the photoresist mask and then affecting the mask repair, after which the developed layer of photoresist is removed.

By providing the indicated method, the claimed invention, as stated in summary form on page 19 of the specification:

"It is clear that the method of the invention for repairing PSM mask 15, as described using Fig. 2 through 9, comprises:

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- the pattern 22 of opaque shifter elements having been protected by a layer of photoresist during the repair operation, avoiding problems of impacting the transmission characteristics of the shifter and impacting the phase angle characteristics of the PSM, and
- the Ga stain has been removed from the surface of the substrate 10."

Claims 2-7 provide essential and important detailed specification for the implementation of the claimed invention in support of independent claim 1.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 1-7 under 35 U.S.C. 102(e), be withdrawn.

Claim rejections - 35 U.S.C. § 103

Reconsideration of the rejection of claims 1-28 under 35 U.S.C. 103(a) as being unpatentable over Grenon et al. (U.S. Patent 6,165,649) in view of the disclosed prior art is respectfully requested based on the following.



The relative merits of the Grenon et al. invention with respect to the instant claimed invention have been highlighted in detail above and are enclosed at this time by reference as being equally applicable to claims 1-28.

The disclosed prior art does not refer to the essential aspects and provisions of the claimed invention, but has been highlighted merely to indicate some of the aspects of repairing a photomask, such as repairing an excess deposition 14 of opaque material, as shown in the cross section of Fig. 1a, or the repairing of a deficiency 18 of light shifting material, as shown in the cross section of Fig. 1a. At no time has the disclosed prior art even addressed any actions that might be taken to repair the indicated defects in a photoresist mask, in fact the specification states, that, as quoted from the last paragraph on page 13 of the specification:

"Other considerations of repair apply to the repair of phase shifter mask, relating to for instance the size of the irregularities that are present in the phase shifter mask. Since however these concerns and considerations are not germane to the invention, they will not be further highlighted as part of the

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invention. Suffice it to be aware of the principles of some of the methods of repairing a phase shifter mask, a complete survey of these methods would be too lengthy an undertaking while making no substantial contribution to the invention."

In short: the Admitted Prior Art (AAPA) merely highlighted some of the defects that may occur in a photomask without however further addressing how, in general, these defects are repaired.

Claim 1 has been quoted supra, the comments that have been provided relating to claim 1 above equally apply to illustrate the differences of the claimed invention over Grenon et al. in view of the disclosed prior art and are enclosed as this time by reference as being equally applicable to over Grenon et al. in view of the disclosed prior art, further emphasizing the patentability of the claimed invention over Grenon et al. in view of the disclosed prior art.

To as yet further highlight this latter aspect of the patentability of the claimed invention over Grenon et al. in view of the disclosed prior art, independent claim 14, which specifies a method of repairing a Phase Shift Mask (PSM), while

maintaining desired transmission rate and phase angle of the PSM, and supporting claim 16, which specifies creating a layer of protective semiconductor material over the surface of the pattern of phase shifter material provided over the second surface of the PSM including the surface of the at least one faulty element in the pattern of phase shifter material, as follows:

Claim 14:

- providing a Phase Shift Mask (PSM) having a first and a second surface, the PSM having been provided with a pattern of phase shifter material over the second surface of the PSM, the pattern of phase shifter material comprising at least one faulty element
- creating a layer of protective semiconductor material over the surface of the pattern of phase shifter material provided over the second surface of the PSM, including the surface of the at least one faulty element in the pattern of phase shifter material
- repairing the at least one faulty element in the pattern of phase shifter material
- removing a Ga stain from the second surface of the PSM, and

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- removing the layer of protective layer of semiconductor material from the surface of the pattern of phase shifter material provided over the second surface of the PSM.

Claim 16:

- depositing a layer of protective semiconductor material over the second surface of the Phase Shift Mask, including the surface of the pattern of phase shifter material provided over the second surface of the PSM
- exposing the first surface of the PSM, thereby exposing the deposited layer of protective semiconductor material except where the layer of protective semiconductor material is shielded by the pattern of phase shifter material provided over the second surface of the PSM, and
- developing the exposed layer of protective semiconductor material, removing the layer of protective semiconductor material from in between the pattern of phase shifter material over the second surface of the PSM, leaving the layer of protective semiconductor material in place overlying the pattern of phase shifter material including the at least one faulty element.

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To summarize, thereby highlighting the patentability of the claimed invention over Grenon et al. in view of the disclosed prior art:

1. Grenon et al. provides a protective layer for the protection of surfaces that potentially may be damaged during actions of photomask repair and then performs the repair action, and
2. the claimed invention provides a layer of photoresist, created by exposure of a first surface of a photomask while the opaque pattern has been created over a second surface of a photomask, for the protection of the opaque pattern including the to be repaired fault in the photomask, and then performs the repair action.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 1-28 under 35 U.S.C. 103(a) as being unpatentable over Grenon et al. (U.S. Patent 6,165,649) in view of the disclosed prior art, be withdrawn.

#### Other Considerations

No new independent or dependent claims have been written as a result of this office action, no new charges are therefore incurred due to this office action.

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It is requested that, should Examiner not find the claims to be allowable, to call the undersigned Attorney at the Examiner's convenience at 845-452-5863 in order to overcome any problems preventing allowance of the claims.

Respectfully submitted,

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